

MODIS Land Data Operational Product Evaluation (LDOPE) Tools

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Land Processes Distributed Active Archive Center (LP DAAC)

USGS EROS Data Center

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Introduction

To continue a strong commitment to the US space program, the National Aeronautics and Space Administration (NASA) has undertaken a program of long-term observation, research, and analysis of the Earth's land, oceans, atmosphere and their interactions, including measurements from the Earth Observing System (EOS). The EOS is funded by the NASA Earth Science Enterprise (ESE) Program and has three main components, (i) a coordinated series of Earth-observing satellites, (ii) an advanced data system designed to support the production, archival, and dissemination of satellite derived data products, (iii) teams of scientists who are developing the science algorithms to make the data products. The Moderate Resolution Imaging Spectroradiometer (MODIS) is a key instrument onboard the EOS Terra satellite, successfully launched in December 1999 and again on the Aqua satellite in 2002.

The MODIS Land (MODLAND) Science Team (ST) is funded by NASA to develop the science algorithms and processing software used to generate the MODLAND products. For more information, see the MODLAND special edition of *Remote Sensing of Environment*, November 2002, Vol. 83, Issues 1-2. The standard MODLAND products are sent to Distributed Active Archive Centers (DAACs) for archive and distribution to the user community. The MODLAND cryospheric products are sent to the National Snow and Ice Data Center DAAC and the non-cryospheric land products are sent to the Earth Resources Observation Systems (EROS) Data Center (EDC) DAAC.

The MODIS Land Data Operational Product Evaluation (LDOPE) facility was formed to support the MODLAND ST and to provide a coordination mechanism for MODLAND's quality assessment (QA) activities (Roy, D.P., Borak, J.S., Devadiga, S., Wolfe, R.E., Zheng, M., Descloitres, J., 2002, The MODIS Land Product Quality Assessment Approach, *Remote Sensing of Environment*, 83, 62-76). LDOPE personnel develop and maintain software tools for the manipulation, visualization and analysis of the MODLAND products. The tools have been developed with feedback from the MODLAND ST and incorporate the scientific knowledge, experience and insights gained during the substantial MODLAND product development period. They have been distributed in versioned drops within the ST in response to ST bug fix requests and requests for new functionality.

A subset of the LDOPE QA tools is being made available to the MODLAND product user community. Several of the tools may also be used to manipulate non-MODLAND HDF-EOS products. The tools are provided as command line executables running on a small number of operating systems and distributed via the Internet from the EDC DAAC with full documentation and installation instructions. The tools are written in C and may be run at the command line or called from scripts and other packages. They are invoked using an UNIX-like command and argument syntax.

This activity was funded by an unsolicited proposal to NASA, "Data Analysis Tools for the MODIS Land User Community", 2002, D. Roy, S. Devadiga, J. Dwyer.

MODIS LDOPE Tools Capabilities

The following table describes two sets of tools that will be released to the public in separate deliveries. Complete command line syntax for each of the tools will be provided at the time of actual delivery. This document will be updated with each delivery.

Drop 1 Tools

Linux & Irix versions [made available on December 6, 2002]

Solaris & Windows versions [made available on March 7, 2003]

Tool Name	Description
enlarge_sds	The inverse of companion tool <i>reduce_sds</i> . Simulate finer resolution data by pixel replication.
mosaic_sds	Create a spatial mosaic of SDSs from different L3 MODLAND products. Specified SDSs are spatially arranged based either on their geolocation or in a user specified manner.
read_meta	Print the ECS core and archive metadata and SDS attributes of any MODLAND product.
read_l2g	The MODLAND L2G products store one or more L2 observations for each L2G pixel in a series of layers (that reflect the MODIS orbit overpass and swath sensing geometry) in a compressed run length encoded format. This tool reads the L2G format and writes user specified layers to output 2D HDF Science Data Sets (SDSs) that can be read by commercial of the shelf (COTS) software.
reduce_sds	Generate reduced spatial resolution MODLAND product SDSs by sub-sampling or averaging. Handle the MODLAND product no-data and missing values. This may be used to reduce data volumes, and to quickly enable analysis of the different MODLAND product spatial resolutions (250m, 500m, 1km), or to enable comparison with other coarser spatial resolution data sets.
reduce_sds_rank	Several MODLAND products (e.g., MOD43) and related MODIS products (e.g., MOD35) contain multidimensional SDSs. This tool converts multidimensional (3D or 4D) SDS to a series of 2D HDF SDSs that can be read by conventional COTS.
sds2bin	Convert an SDS of any HDF-EOS file to a flat binary image format.
unpack_sds_bits	The MODLAND product per-pixel QA information and other information such as the land-sea mask, logical criteria used by the algorithm, and cloud state are stored in an efficient bit encoded manner. This tool decodes requested bit fields and writes them to 2D HDF SDSs that can be read by conventional COTS.

Drop 2 Tools

Linux, Irix, Solaris & Windows versions to be made available Fall 2003

Tool Name	Description
create_mask	Apply relational and boolean operators to one or more SDS in one or more MODLAND products to create an output 2D HDF SDS that can be read by conventional COTS. For example, create a binary SDS that shows the pixel locations where only good quality, non-cloudy, 16-day vegetation index values with a land cover type = 3 were produced.

mask_sds	Use relational and boolean operators applied to one or more SDS in one or more MODLAND products, or the output of <i>create_mask</i> , to create one or more output 2D HDF SDS that contain masked MODLAND SDS values. For example, create an SDS that contains MODIS land surface temperature product values at the locations where only good quality, non-cloudy, 16-day vegetation index values with a land cover type = 3 were produced.
mask_l2g_srefl	This is a specific implementation of the generic tool <i>mask_sds</i> , incorporating the sophisticated options required to interpret the MODLAND L2G product format. This tool may be used for example, to produce gridded daily cloud-free, good quality land surface reflectance 2D HDF SDSs that can be read by conventional COTS.
tileid	Compute the MODLAND L2G, 3, 4 tile id for a given latitude and longitude. This tool identifies the MODLAND tile that corresponds to a known geographic location.
geolocation	Compute the latitude and longitude of a MODLAND L2G, 3, 4 pixel coordinate.
read_proj_param	Print the metadata projection parameters contained in any L2G, 3, 4 MODLAND product.
cp_proj_param	Write projection metadata into any HDF file that is defined in the MODLAND Integerized Sinusoidal Projection. The HDF file may then be reprojected using the EDC reprojection tool. This allows reprojection of filtered and masked MODLAND product SDS.
sds_range	Print the observed range, excluding no-data and missing values, of specified SDSs in any MODLAND product.
sds_values	Print all the unique values found in specified SDSs of any MODLAND product. This tool is most useful for summarizing the data distribution of SDSs that have few expected values and categorical SDSs (e.g., the MODLAND snow and fire products).
sds_hist	Print the histogram of SDS values (frequency and value), excluding no-data and missing values, over a user-requested data range.
comp_sds_stat	Print summary statistics (mean, standard deviation, minimum, maximum and number of observations) of any SDS, excluding no-data and missing values, of any MODLAND product.
read_pixvals	Print user specified SDS values at a specified pixel location for a given list of MODLAND products. Appropriate offsets are applied automatically to handle the different MODLAND product spatial resolutions.
conv_l1bdata	Convert MODIS L1B data counts to Top of Atmosphere (TOA) reflectance for the MODIS reflective bands and TOA radiance for the MODIS emissive bands and write these to 2D HDF SDS(s) that can be read by conventional COTS. The conversion is performed using the scale and off-sets defined in the MODIS L1B product metadata.
create_250m_srefl	MODIS has seven reflective bands for land studies, two 250m bands and five 500m bands. This tool "sharpens" specified 500m bands to 250m by multiplying them with the ratio of the 250m and 500m 0.645 μm data. This is useful for visualization of the MODLAND 250m products.

enlarge_sds

NAME

enlarge_sds – enlarge the spatial dimensions of one or more SDS from a MODIS Land HDF-EOS data product by pixel replication.

SYNOPSIS

enlarge_sds -help [filename]

enlarge_sds -of=<output filename> -sf=<scale factor>
[-sds=<SDSname1>[<,SDSname2>...]] [-meta] filename

DESCRIPTION

Each pixel value at (i, j) in the input SDS is duplicated from (sf*i, sf*j) to (sf*i + sf - 1, sf*j + sf - 1) pixels in the output SDS. The enlargement scale factor (sf) must be a non-zero positive integer. The output is an HDF-EOS file. One or more SDSs may be enlarged.

This tool can be used to create fine resolution data set from a coarse resolution data set, e.g., a 500m resolution data set can be created from an input 1km resolution data set using a scale factor of 2. The output dataset will have blocky structure due to pixel replication.

This tool is complemented by the tool *reduce_sds*.

This tool supports 2D/3D/4D SDS(s).

The tool command arguments can be specified in any order.

ARGUMENTS

- help [filename] Display this help message. If the input filename is specified with this option, then the names of all the SDS in the file are displayed.
- of=<filename> Output filename.
- sf=<factor> Scale factor (a non-zero positive integer).
- sds=<SDS list> List of SDS to enlarge. SDS names are separated by commas with no space. By default all SDSs are processed maintaining the input SDS interleaving.

To process a specific layer of a 3D SDS specify the element number of the third dimension as a dot extension of the SDS name: sds_name.n (e.g., sur_refl_b02.1 = the layer defined by the 1st element of the 3rd dimension of the 3D SDS sur_refl_b02).

To process a specific layer of a 4D SDS, specify the higher dimension element number(s) as a dot extension of the SDS name: sds_name.n.m (e.g., Surface_Refl.1.2 = the layer defined by the 1st element of the 3rd dimension and the 2nd element of the 4th dimension of the 4D SDS Surface_Refl).

Note that wildcards and ranges of element values may be specified as sds_name.* and as sds_name.n1-n2.m respectively.

-meta Copy metadata from input to output file.
filename Input filename.

EXAMPLES

```
enlarge_sds -help MYD021KM.A2002189.0350.003.2002191000652.hdf
```

```
enlarge_sds -sds=EV_500_Aggr1km_RefSB.2 -sf=2 -of=refsb_x2.hdf  
MOD021KM.A1996213.1024.002.hdf
```

```
enlarge_sds -sds="EV_500_Aggr1km_RefSB.2-4" -sf=4 -of=refsb_x4.hdf  
MOD021KM.A002189.0350.003.2002191000652.hdf
```

```
enlarge_sds -sf=4 -sds="Cloud_Mask.*,Quality_Assurance" -  
of=myd35_x4.hdf -meta  
MYD35_L2.A2002189.2040.003.2002191125354.hdf
```

```
enlarge_sds -sf=4 -of=refsb_1kmtto250m.hdf -sds="EV_1KM_RefSB.4-6"  
MYD021KM.A2002189.0350.003.2002191000652.hdf
```

```
enlarge_sds -sds="BRDF_Albedo_Parameters.*.2" -sf=2 -meta -  
of=brdf_x2.hdf  
MYD43B1.A2002177.h11v11.003.2002210233848.hdf
```

{Note: This example enlarges selected layers of a 4D SDS. All the layers defined by all the elements of the 3rd dimension and the 2nd element of the 4th dimension of the SDS BRDF_Albedo_parameters are enlarged using a scale factor of 2. The metadata is copied from the input file to the output file. }

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

mosaic_sds

NAME

mosaic_sds - prepare a mosaic of SDSs from L3/L4 MODIS Land HDF-EOS data products.

SYNOPSIS

mosaic_sds -help [filename]

mosaic_sds -of=<output filename> [-sds=<SDSname1>[<,SDSname2>...]]
[-fill=<fill value>][-gr=<nh,nv>] [-gr=<hb, vb>]
f1 [-row=<min,range>] [-col=<min,range>] f2 [-row=<min,range>] [-
col=<min,range>]
f3 [..[f4...]]

DESCRIPTION

Create a spatial mosaic from different L3/L4 MODIS Land HDF-EOS data products. Specified SDSs are spatially arranged based either on their geolocation (defined by their tile id) or in a user specified manner. The horizontal and vertical tile numbers are identified from the filename or from the VERTICALTILENUMBER and HORIZONTALTILENUMBER metadata. Any missing tiles (i.e. gaps in the output mosaic) are replaced with a user specified fill value. Multiple SDSs are written to the mosaic if two or more SDSs are listed in the input argument

If the tile id is not recognized in one or more of the input files, then the tiles may be mosaiced with a user specified number of output horizontal and vertical tiles using the -gr option. If the tile id is not recognized and the -gr option is not used, then the tiles are mosaiced in an optimal "least-space" row column order. In either case the first file in the filenames list is placed in the north-west corner and the last file in the south-east corner.

This tool supports 2D/3D/4D SDSs.

The tool command arguments can be specified in any order.

ARGUMENTS

-help [filename]	Display this help message. If the input filename is specified with this option, then the names of all the SDS in the file are displayed.
-of=<filename>	Output filename.
-sds=<SDS list>	List of SDSs to mosaic. The SDS names are separated by commas with no space. By default

all SDSs are processed maintaining the input SDS interleaving.

To process a specific layer of a 3D SDS, specify the element number of the third dimension as a dot extension of the SDS name: sds_name.n (e.g., sur_refl_b02.1 = the layer defined by the 1st element of the 3rd dimension of the 3D SDS sur_refl_b02).

To process a specific layer of a 4D SDS, specify the higher dimension element number(s) as a dot extension of the SDS name: sds_name.n.m (e.g., Surface_Refl.1.2 = the layer defined by the 1st element of the 3rd dimension and the 2nd element of the 4th dimension of the 4D SDS Surface_Refl).

Note that wildcards and ranges of element values may be specified as sds_name.* and as sds_name.n1-n2.m respectively.

- row=<min,max> Range of SDS rows to be included in the mosaic. (default: all rows). Input for each file separately following the input filename.
- col=<min,max> Range of SDS columns to be included in the mosaic. (default: all columns). Input for each file separately following the input filename.
- fill=<fill value> Output fill value for missing “gap” tiles. The fill value must be within the valid range of the input SDS data type, e.g., if the input SDS is of type INT8 then valid range for the fill value is {-128 :127}. If no fill value is specified a fill value equal to the input SDS fill value is used.
- gr=<nh,nv > Number of horizontal and vertical tiles in the output mosaic where each tile is occupied by one of the input tile. If -gr option is not specified and tile ids are not recognized, then the tiles are arranged in a “least-space” manner.
- f1 f2 f3 Input filenames (followed by -row and -col options if subset is required).

EXAMPLES

```
mosaic_sds -sds=fire_mask_1 -of=fire_mask.2002186.003.mosaic.hdf  
MYD14GD.A2002186.h20v09.003.2002190153045.hdf
```

```
MYD14GD.A2002186.h20v10.003.2002190153230.hdf
MYD14GD.A2002186.h21v09.003.2002190153400.hdf
MYD14GD.A2002186.h21v10.003.2002190153645.hdf
```

{Note: This example creates a mosaic of SDS fire_mask_1 from the four specified MYD14GD files and outputs the mosaic to a file called fire_mask.2002186.003.mosaic.hdf }

```
mosaic_sds -sds=fire_mask_1,num_observations -of=myd14gd_mosaic.hdf
MYD14GD.A2002189.*.003.*.hdf
```

{Note: This example creates a mosaic containing two SDSs (fire_mask_1 and num_observations) from all the MYD14GD files of day 2002189 under the current working directory which satisfy the wild card.}

```
mosaic_sds -
sds=sur_refl_b01_1,sur_refl_b02_1,sur_refl_b03_1,sur_refl_b04_1
-of=myd09ghk_mosaic.hdf -fill=-1000 MYD09GHK.A2002186.h2*.hdf
```

```
mosaic_sds -sds=sur_refl_b01,sur_refl_b02
-of= tst12_mosaic_MOD09A1.A2001201.h20-21.v05-06.hdf
MOD09A1.A2001201.h20v05.003.2002281080105.hdf -
row=1500,2399 -col=1000,2399
MOD09A1.A2001201.h20v06.003.2002281080112.hdf
-row=0,1200 -col=1000,2399
MOD09A1.A2001201.h21v05.003.2002281080255.hdf
-row=1500,2399 -col=0,1200
MOD09A1.A2001201.h21v06.003.2002281080110.hdf
-row=0,1200 -col=0,1200
```

```
mosaic_sds -sds=fire_mask_1 -row=0,599 -col =0,599 -
of=fire_mask_mosaic.hdf MYD14GD.A2002186.*.hdf
```

```
mosaic_sds -sds=EV_Band26 -fill=-100 -gr=3,3 -of =myd021km_mosaic.hdf
MYD021KM.A2002189.07*.hdf
```

```
mosaic_sds -sds ="BRDF_Albedo_Parameters.1.2" -of=brdf_mosaic.hdf
MYD43B1.A2002177.h*.hdf
```

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

read_l2g

NAME

read_l2g - read specified layers or granules from a MODIS Land L2G HDF-EOS data product and write out to 2D SDSs.

SYNOPSIS

```
read_l2g -help [filename]
```

```
read_l2g -of=<output filename> -layer[=layer1[,layer2...]] -  
  glist[=orbit,gran1[,gran2...]]  
  -gpidx[=index1[,index2...]] -gid=[granule1[,granule2..]] [-meta]  
  [-sds=<SDSname1>[<,SDSname2>...]] [-ptr=<pointer file>]  
  filename
```

DESCRIPTION

The different MODIS Land L2G HDF data products store one or more L2 observations for each L2G pixel in a series of layers (that reflect the MODIS orbit overpass and swath sensing geometry) in a compressed run length encoded format. This tool extracts SDSs from a MODIS Land L2G file, selecting observations according to the layer number, granule number, granule pointer index, or granule id and writes them to an output HDF-EOS file as separate 2D SDSs.

The output file SDS names reflect the input SDS name and the layer number, granule number, granule pointer index, or granule id. For example:

sur_refl_b01_layer2 (layer 2 of input SDS 'sur_refl_b01'),

fire_mask_gran166_orb8318 (granule 166 from orbit 8318 of input SDS 'fire_mask'),

SolarZenith_gpnt2 (granule with granule pointer index 2 of input SDS 'SolarZenith'),

Snow_Cover_A2001192.1340 (granule with granule id A2001192.1340 of input SDS 'Snow_Cover').

Note that the associated L2G pointer file must be defined in the argument list if observations are selected by granule number, granule pointer index or granule id.

This tool supports L2G only.

The tool command arguments can be specified in any order.

ARGUMENTS

-help [filename]	Display this help message. If the input filename is specified with this option, then the valid values for options <code>-layer</code> , <code>-glist</code> , <code>-gpidx</code> , <code>-gid</code> , <code>-ptr</code> , and <code>-sds</code> are displayed.
-of=<filename>	Output filename.
-layer=layer1[,layer2...]	Select by layer number (1-based). If this option is specified without any value, then all layers are output.
-glist=orbit,gran1[,gran2...]	Select by granule number using orbit and granule number as the unique granule identification. To select granules from an orbit enter the orbit number followed by the granule numbers. Repeat the option to select granules from additional orbits. If this option is specified without any value, then all granules are output.
-gpidx=index1[,index2...]	Select by granule pointer index (0 based). If this option is specified without any value, then all granules are output.
-gid=granule1[,granule2...]	Select by granule ID (e.g., Ayyyyddd.hhmm). If this option is specified without any value, then all granules are output.
-sds=<SDS list>	List of SDS to read. SDS names are separated by commas with no space. By default all SDS in the file are read. SDS names are input without the <code>_1</code> and <code>_c</code> extensions used to indicate the first layer and the compact layer SDS, e.g., although the MOD09GHK files contain SDS <code>sur_refl_b01_1</code> and <code>sur_refl_b01_c</code> , the SDS name should be specified as <code>sur_refl_b01</code> .
-ptr=pointer filename	Pointer filename. Required if reading an SDS by the identity of the L2 granule, using <code>-glist</code> , <code>-gpidx</code> or <code>-gid</code> option.
-meta	Copy metadata from input file to output file.
filename	Input filename.

EXAMPLES

```
read_l2g -layer=1-2 -sds=Snow_Cover -of=myd10l2g_layers1_2.hdf
MYD10L2G.A2002177.h09v05.003.2002180140700.hdf
```

{Note: This example extracts the first and second layers of SDS Snow_Cover from the input MYD10L2G file.}

```
read_l2g -sds=fire_mask -glist=13928,230,231 -
of=fire_mask_orbit13928.hdf -meta
-ptr=MODPT1KD.A2002212.h09v05.003.2002218193538.hdf
MOD14GD.A2002212.h09v05.003.2002218194510.hdf
```

{Note: This example extracts granules 230 and 231 of orbit 13928 of SDS fire_mask from the input MOD14GD file. Two SDSs are written to the output file. The associated MODPT1KD.2002212.h09v05.003.2002218193538.hdf pointer file has to be specified. The metadata is copied from the input file to the output file.}

```
read_l2g -sds=sur_refl_b01,sur_refl_b03,sur_refl_b04 -layer=1-3
-glist=8319,186 -of=mod09gst_grans8319_layers1_3.hdf
-ptr=MODPTHKM.A2001192.h12v09.003.2001309125954.hdf
MOD09GHK.A2001192.h12v09.003.2001309142732.hdf
```

{Note: This example extracts granule number 186 of orbit 8319 and layers 1 to 3 of the SDSs sur_refl_b01, sur_refl_b03, sur_refl_b04 from the input MOD09GHK file. Twelve SDSs are written to the output file. The associated pointer file MODPTHKM.A2001192.h12v09.003.2001309125954.hdf has to be specified.}

```
read_l2g -sds=SolarZenith,SolarAzimuth,SensorZenith,SensorAzimuth
-gpidx=0-1 -of=modmggad_granid0_1.hdf
-ptr=MODPT1KD.A2002212.h09v05.003.2002218193538.hdf
MODMGGAD.A2002212.h09v05.003.2002218193604.hdf
```

{Note: This example extracts the first two granules (defined in the associated MODPT1KD file with granule pointer index 0 to 1) from the input MODMGGAD file of SDSs SolarZenith, SolarAzimuth, SensorZenith and SensorAzimuth. Eight SDSs are written to the output file. The associated pointer file MODPT1KD.2002212.h09v05.003.2002218193538.hdf has to be specified.}

```
read_l2g -sds=state_1km -gid=A2002212.1900,A2002212.1905 -meta
-of=mod09gst_gran_a2002212.003.hdf
-ptr=MODPT1KD.A2002212.h09v05.003.2002218193538.hdf
```

MOD09GST.A2002212.h09v05.003.2002218193744.hdf

{Note: This example extracts granules with granule id A2002212.1900 and A2002212.1905 of SDS state_1km from the input MOD09GST file. Two SDSs are written to the output file. The pointer file MODPT1KD.2002212.h09v05.003.2002218193538.hdf associated with MOD09GST.A2002212.h09v05.003.2002218193744.hdf has to be specified. The metadata is copied from the input file to the output file.}

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

read_meta

NAME

read_meta - read metadata from any MODIS Land HDF-EOS data product.

SYNOPSIS

read_meta -help

read_meta [-core|arch|qa] [-meta=<metadata1>[<,metadata2>...]] [-case] filename(s)

DESCRIPTION

Read a set of specified metadata from MODIS Land HDF-EOS file(s) and write the output to stdout. If no options are specified, all metadata are read. Option -case allows the metadata names to be specified case insensitive.

The tool command arguments can be specified in any order.

ARGUMENTS

-help	Display this help message.
-core	Print core metadata.
-arch	Print archive metadata.
-qa	Print only QA metadata.
-meta=<metadata list>	Print the specified metadata. This option is ignored if one of the options above is used. Metadata names are separated by commas with no space.
-case	Make specified metadata name(s) case insensitive. This option can be used only with the -meta option.
filename(s)	One or more input files separated by space. Files are processed in the order they are listed in the command line.

EXAMPLES

```
read_meta -meta=AUTOMATICQUALITYFLAG MOD09GHK.*.hdf
read_meta MYD021KM.A2002189.0350.003.2002191000652.hdf
read_meta -arch MOD021KM.A2002189.0350.003.2002191000652.hdf
read_meta -core MYD09GHK.A2002177.h09v05.003.2002180140102.hdf
read_meta -qa MYDPTHKM.A2002177.h09v05.003.2002180134421.hdf
read_meta -meta=EQUATORCROSSINGDATE -case
    MYD09GHK.A2002177.h09v05.003.2002180140102.hdf
read_meta -meta= DAYNIGHTFLAG, GRINGPOINTLONGITUDE,
    GRINGPOINTLATITUDE MYD03.A2002*.hdf
```

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

reduce_sds

NAME

reduce_sds - reduce the spatial dimensions of one or more SDSs of a MODIS Land HDF-EOS data product.

SYNOPSIS

reduce_sds -help [filename]

reduce_sds -of=<output_filename> -rf=<reduction factor> -sub|avg|cnt|cl
[-sds=<SDSname1>[<,SDSname2>...]]
[-bit=[<bit range>]<opr><value>[, [<bit range>]<opr><value>]...]
[-min] [-max] [-std] [-num] [-meta] [-float] filename

DESCRIPTION

The spatial dimensions of input SDS(s) may be reduced using one of four different methods. The reduction factor (rf) must be a non-zero positive integer. The output SDS x dimension will be $((x \text{ div } rf) + (x \text{ mod } rf))$ and similarly the y dimension will be $((y \text{ div } rf) + (y \text{ mod } rf))$. If the input SDS list contains SDSs with different spatial dimensions the reduction factor will be applied to the SDS with the smallest spatial dimension and the other SDS(s) will be reduced to have the same output dimension.

All SDS fill values are ignored.

This tool may be used to reduce data volumes, and to enable analysis of the different MODLAND product spatial resolutions (250m, 500m, 1km), or to enable quick comparison with other coarser spatial resolution data sets.

This tool compliments the tool *enlarge_sds*.

This tool supports 2D/3D/4D SDS(s).

The tool command arguments can be specified in any order.

ARGUMENTS

-help [filename]	Display this help message. If the input filename is specified with this option, then the names of all the SDSs in the file are displayed.
-of=<filename>	Output filename
-rf=<reduction factor>	Reduction factor (a non-zero positive integer)

- sub Reduce by sub-sampling. Pixel value at (i, j) in the output SDS is copied from the pixel at (rf*i + rf/2, rf*j + rf/2) in the input SDS.
- avg Reduce by averaging. Pixel value at (i, j) in the output SDS is the average of pixel values in a sub window defined from (rf*i, rf*j) to (rf*i + rf - 1, rf*j + rf - 1) in the input SDS. Optional minimum, maximum, standard deviation, and number of averaged pixels may be output as separate SDS.
- cnt Reduce by pixel counting. Pixel value at (i, j) in the output SDS is the number of pixels in a sub window defined from (rf*i, rf*j) to (rf*i + rf - 1, rf*j + rf - 1) in the input SDS with bit value equal to the user specified value. Relational operators may be used. The output SDS value is in the range {0 : rf x rf}.
- cl Reduce by majority class value. Pixel value at (i, j) in the output SDS is set to the majority value of the pixels in a sub window defined from (rf*i, rf*j) to (rf*i + rf - 1, rf*j + rf - 1). This option is best used for data with a small number of nominal pixel values.
- sds=<SDS list> List of SDSs to reduce. SDS names are separated by commas with no space. By default all SDSs are processed maintaining the input SDS interleaving.
- To process a specific layer of a 3D SDS specify the element number of the third dimension as a dot extension of the SDS name: sds_name.n (e.g., sur_refl_b02.1 = the layer defined by the 1st element of the 3rd dimension of the 3D SDS sur_refl_b02).
- To process a specific layer of a 4D SDS, specify the higher dimension element number(s) as a dot extension of the SDS name: sds_name.n.m (e.g., Surface_Refl.1.2 = the layer defined by the 1st element of the 3rd dimension and the 2nd element of the 4th dimension of the 4D SDS Surface_Refl).

Note that wildcards and ranges of element values may be specified as `sds_name.*` and as `sds_name.n1-n2.m` respectively.

- `-bit=[<bit range>]<operator>< value>,[<bit range>]<operator><value>, . . .`
This option is applicable only with the `-cnt` option. The SDS bit range and corresponding value are specified in decimal separated by a relational operator. If the bit range is not specified the tool considers all the bits in the SDS. Multiple range, operator and value combinations separated by commas will result in separate output SDS for each of such combination. Valid relational operators are: `==, <, >, <=, >=, !=`
- `-std` Compute the standard deviation in each sub window (for `-avg` option only).
- `-min` Compute the minimum value in each sub window (for `-avg` option only).
- `-max` Compute the maximum value in each sub window (for `-avg` option only).
- `-num` Compute the number of averaged pixels in each sub window (for `-avg` option only).
- `-meta` Copy metadata from input file to output file.
- `-float` Output average value SDS in float data type, default is the input data type (for `-avg` option only).
- `filename` Input filename.

EXAMPLES

```
reduce_sds -sds=Fpar_1km -sub -rf=10 -of=sub_fpar.hdf
MOD15A1.A2001193.h09v05.004.2002198025239.hdf
```

{Note: This example reduces the spatial dimensions of SDS `Fpar_1km` by 10 using the sub-sampling method. The output file will have spatial dimensions approximately 10 times smaller.}

```
reduce_sds -sds=Lai_1km -avg -min -max -std -num -rf=10 -of=avg_lai.hdf  
MOD15A1.A2001193.h09v05.004.2002198025239.hdf
```

```
reduce_sds -sds=Cloud_Mask -sub -rf=5 -of=cloud_sub.hdf  
MYD35_L2.A2002189.2040.003.2002191125354.hdf
```

```
reduce_sds -sds=Cloud_Mask.1-2 -avg -rf=5 -of=cloud_avg.hdf  
MYD35_L2.A2002189.2040.003.2002191125354.hdf
```

```
reduce_sds -cnt -bit="0-3<=2,0-3==3,0-3==4,0-3==5,0-3==6,0-3==7" -  
meta -sds="most confident detected fire" -rf=5 -of=fire_class.hdf  
MOD14A1.A2002185.h30v11.003.2002204204451.hdf
```

```
reduce_sds -rf=2 -cl -of=land_cover_class.hdf  
MOD12Q1.A2000289.h01v11.003.2002171021653.hdf
```

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

reduce_sds_rank

NAME

reduce_sds_rank – convert one or more 3D/4D SDS from a MODIS Land HDF-EOS data product to many 2D SDSs.

SYNOPSIS

```
reduce_sds_rank -help [filename]
```

```
reduce_sds_rank -of=<output filename>  
{[-sds=<SDSname> [-dim=<dimstr> [-dim=<dimstr>. . ]]]} [-all] [-meta]  
filename
```

DESCRIPTION

Several MODIS Land HDF-EOS data products (e.g., MOD43, MYD43) and related MODIS products (e.g., MOD35) contain multidimensional SDSs. This tool converts one or more multidimensional (3D or 4D) SDSs to a series of 2D HDF SDSs. Specific SDS layers may be selected using the `-sds` and `-dim` options for each input 3D or 4D SDS.

The output file SDS names reflect the input SDS name, the dimension name and the dimension element numbers. For example:

```
BRDF_Albedo_Parameters.Num_Land_Bands_Plus3_3.Num_Parameters_1  
(parameter 1 for land band 3 of SDS BRDF_Albedo_Parameters in MOD43B1. Note that BRDF_Albedo_Parameters is the input SDS name, Num_Land_Bands_Plus3 and Num_Parameters are the 3rd and the 4th dimension names)
```

```
Surface_Refl.Num_Obs_Max_1.Num_Land_Bands_2 (1st observation of land band 2 of SDS Surface_Refl in MODAGAGG. Note that Surface_Refl is the input SDS name, Num_Obs_Max and Num_Land_Bands are the 3rd and the 4th dimension names)
```

```
Angles.Num_Obs_Max_2.Num_Angles_3 (2nd observation of the 3rd angle component of SDS Angles in MODAGAGG. Note that Angles is the input SDS name, Num_Obs_Max and Num_Angles are the 3rd and the 4th dimension names)
```

This tool supports 3D and 4D SDS(s).

The tool command arguments can be specified in any order.

OPTIONS

- `-help [filename]` Display this help message. If the input filename is provided with this option, then the names of all the SDS in the file with the SDS dimension name and size are displayed.
- `-of=<filename>` Output filename.
- `-sds=<SDS name>` Name of SDS to convert. By default all 3D/4D SDS in the input file are converted to 2D SDSs.
- `-dim=<dimension name, dimension element number(s)>`
Name of the 3rd or higher SDS dimension and the dimension element number(s) (1-based). The dimension element numbers can be separated by comma or by '-'. The `-dim` option must be repeated for each of the defined SDS dimension names, e.g.,
`-dim=Band_id,1-7 -dim=obs_id,0,1.`
- This option should follow the `-sds` option for each input SDS. By default, the tool reduces all of the 3rd and 4th dimensions of a specified SDS.
- `-all` Create an additional output SDS containing all the 2D SDSs mosaiced in a single SDS in row-column order.
- `-meta` Copy metadata from input file to output file.
- `filename` Input filename.

EXAMPLES

```
reduce_sds_rank -sds=BRDF_Albedo_Parameters -  
  dim=Num_Land_Bands_Plus3,1-7  
  -dim=Num_Parameters,1-3 -of=brdf_albedo_2dsds.hdf  
  MYD43B1.A2002177.h11v11.003.2002210233848.hdf
```

{Note: This example extracts twenty-one 2D SDSs from the 4D SDS BRDF_Albedo_Parameters stored in the input MYD43B1file. In this example, the values of the BRDF_Albedo_Parameters 1, 2 and 3 are written as separate 2D SDSs for each of the first 7 land bands. }

```
reduce_sds_rank -sds=Angles -dim=Num_Obs_Max,1-4 -  
dim=Num_Angles,1-4 -all  
-of=agg_angles.hdf  
MODAGAGG.A2002017.h20v11.004.2002203181248.hdf
```

{Note: This example extracts sixteen 2D SDSs from the 4D SDS Angles stored in the input MODAGAGG file. In this example, the values of the four angles (View Zenith, Solar Zenith, Solar Azimuth, View Azimuth) are written as separate 2D SDSs for each of the four observations). An additional output SDS containing all the 2D SDSs in a single SDS in row-column order is also output. }

```
reduce_sds_rank -sds=Surface_Refl -dim=Num_Obs_Max,1,2  
-dim=Num_Land_Bands,1-7 -sds=Band_QC -  
dim=Num_Obs_Max,1,4  
-dim=Num_Band_QC,1-7 -of=agg_angles_bandqc.hdf  
MODAGAGG.A2002017.h20v11.004.2002203181248.hdf
```

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

sds2bin

NAME

sds2bin - Convert an SDS of a MODIS Land HDF-EOS data product to binary format.

SYNOPSIS

sds2bin -help [filename]

sds2bin -of=<output filename> -sds=<SDSname> filename

DESCRIPTION

Convert a user specified SDS from a MODIS Land HDF file to an output binary format file.

The tool supports 2D/3D/4D SDSs.

The tool command arguments can be specified in any order.

ARGUMENTS

-help
[filename] Display this help message. If the input filename is specified with this option, then the names of all the SDS in the file are displayed.

-of=<filename> Output filename.

-sds=<SDS name> SDS to be converted

To process a specific layer of a 3D SDS, specify the element number of the third dimension as a dot extension of the SDS name: sds_name.n (e.g., sur_refl_b02.1 = the layer defined by the 1st element of the 3rd dimension of the 3D SDS sur_refl_b02).

To process a specific layer of a 4D SDS, specify the higher dimension element number(s) as a dot extension of the SDS name: sds_name.n.m (e.g., Surface_Refl.1.2 = the layer defined by the 1st element of the 3rd dimension and the 2nd element of the 4th dimension of the 4D SDS Surface_Refl).

Note that wildcards and ranges of element values may be specified as sds_name.* and as sds_name.n1-n2.m respectively.

filename Input filename.

EXAMPLES

```
sds2bin -sds=sur_refl_b01 -of=sur_refl_b01.img  
MOD09A1.A2001145.h20v10.003.2001214125825.hdf
```

```
sds2bin -sds=EV_1KM_Emissive -of=ev_1km_emissive.img  
MYD021KM.A2002189.2040.003.2002191123800.hdf
```

```
sds2bin -sds="BRDF_Albedo_Parameters.1.2" -of=brdf_albedo.img  
MYD43B1.A2002177.h11v11.003.2002210233848.hdf
```

{Note: This example converts the layer defined by the 1st element of the 3rd dimension and the 2nd element of the 4th dimension of the SDS BRDF_Albedo_parameters to the binary format file brdf_albedo.img. The output is a 2D binary image}

```
sds2bin -sds="BRDF_Albedo_Parameters.1-7.1" -of=brdf_albedo.img  
MYD43B1.A2002177.h11v11.003.2002210233848.hdf
```

{Note: This examples converts the 7 layers defined by the 1st seven elements of the 3rd dimension and the 1st element of the 4th dimension of the SDS BRDF_Albedo_parameters to the binary format file brdf_albedo.img. The 7 layers are output as a single 3D binary image where the number of elements in the 3rd dimension is 7}

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

unpack_sds_bits

NAME

unpack_sds_bits - unpack specified bits from one or more SDS of a MODIS Land HDF-EOS data product.

SYNOPSIS

unpack_sds_bits -help [filename]

unpack_sds_bits -of=<output filename> [-
sds=<SDSname1>[<,SDSname2>...]
-bit=<Bitnumbers> -meta filename

DESCRIPTION

The MODIS Land per-pixel QA information and other information, such as the land-sea mask, logical criteria used by the algorithm, and cloud state, are stored in an efficient bit encoded manner. This tool decodes requested bit fields and writes them to an output HDF file. The output SDS data type is uint8, uint16 or uint32 depending on the number of unpacked bits.

Note that the unpacked bits are stored in the least significant bits of the output SDS. Refer to the MODIS product file specifications for information on which bits to select for unpacking.

This tool supports 2D/3D/4D SDSs.

The tool command arguments can be specified in any order.

ARGUMENTS

-help [filename] Display this help message. If the input filename is specified with this option, then the names of all the SDS in the file are displayed.

-of=<filename> Output filename.

-sds=<SDS list> List of SDSs to process. SDS names are separated by commas with no space. By default all SDSs are processed maintaining the input SDS interleaving.

To process a specific layer of a 3D SDSs specify the element number of the third dimension as a dot extension of the SDS name: sds_name.n (e.g., sur_refl_b02.1 = the layer defined by the 1st element of the 3rd dimension of the 3D SDS sur_refl_b02).

To process a specific layer of a 4D SDS, specify the higher dimension element number(s) as a dot extension of the SDS name: sds_name.n.m (e.g., Surface_Refl.1.2 = the layer defined by the 1st element of the 3rd dimension and the 2nd element of the 4th dimension of the 4D SDS Surface_Refl).

Note that wildcards and ranges of element values may be specified as sds_name.* and as sds_name.n1-n2.m respectively.

-bit=<Bitnumbers> List of bit numbers separated by commas. A range of bit numbers may be specified using '-' between the starting and ending bit numbers, e.g., -bit=4-8.

Note the bit numbers are zero-based and bits are numbered from right (least significant bit) to left (most significant bit), e.g., in the 8 bit number 10101110 the value of bit 2-4 when unpacked is 011.

-meta Copy metadata from input file to output file.

filename Input filename.

EXAMPLES

```
unpack_sds_bits -sds=Cloud_Mask.1 -bit=1-2 -of=cloud_bits.hdf
MYD35_L2.A2002189.2040.003.2002191125354.hdf
```

{Note: This example unpacks bits 1 and 2 of the layer defined by the 1st element of the 3rd dimension of the SDS Cloud_Mask.}

```
unpack_sds_bits -sds=sur_refl_qc_500m -bit=10-13 -of=srefl_qc_bits.hdf
MOD09A1.A2001193.h09v05.004.2002200065231.hdf
```

```
unpack_sds_bits -sds=sur_refl_qc_500m -bit=10-13,14-17,18-21
-of=srefl_qc_bits.hdf
MOD09A1.A2001193.h09v05.004.2002200065231.hdf
```

```
unpack_sds_bits -sds="most confident detected fire" -bit=0-3
-of=fire_bits.hdf
MOD14A1.A2002185.h30v11.003.2002204204451.hdf
```

AUTHOR

Code: S. Devadiga and Yi Zhang
Documentation: S. Devadiga and D. Roy

Version 1.0, 08/08/2002

Contacts

The EROS Data Center is the main support facility for the LDOPE Tools. Please do not contact the developers directly.

SOFTWARE REQUESTS, BUG REPORTS, AND OTHER COMMENTS SHOULD BE SENT TO:

Web: <http://edcdaac.usgs.gov/tools/ldope/register.html>

Mail: **JOHN DWYER**
LP DAAC Project Scientist
SAIC/EROS Data Center
47914 252nd Street
Sioux Falls, SD 57198
Voice: (605) 594-6060
Fax: (605) 594-6567
Email: dwyer@usgs.gov

DOWNLOAD AND INSTALLATION ASSISTANCE should be sent to:

Mail: **CAROLYN GACKE**
Technical Specialist
SAIC/EROS Data Center
47914 252nd Street
Sioux Falls, SD 57198
Voice: (605) 594-6822
Fax: (605) 594-6963
Email: cgacke@usgs.gov

Appendix A: IRIX Installation

Requirements

These tools work on SGI/IRIX 6.5 Operating Systems.

These tools are available as source code that will need to be compiled or as ready-to-run (run-time) binary executables.

If you wish to compile the source code, you will need the HDF4.1r1 library included with this delivery and a 64-bit C compiler.

If you already have HDF4.1r1 installed on your machine you may not need to install it again, otherwise please follow the instructions for HDF installation provided below. For additional information on the HDF library refer to Appendix E.

It is recommended that a 64-bit C compiler is used. A 32-bit compiler will work but it may generate warning messages during the LDOPE tool installation (e.g., >read_l2g_comp.c warning: decimal constant is so large that it is unsigned).

Instructions for Run-time

1. Save the LDOPE_Irix_bin.tar file to a directory where you want to install the software. Untar the LDOPE_Irix_bin.tar file.
>tar -xvf LDOPE_Irix_bin.tar
There will be one file for each executable, and these run as stand-alone commands. These were compiled under the Irix 6.5 Operating system using a 64-bit compiler.

For convenience you may want to add this binary directory path to the \$PATH environment variable.

2. You may wish to test the correct functioning of the tools using the test data sets described in Appendix G.

Instructions for Source Code

1. Save the LDOPE_irix.tar file to a directory where you want to install the software. Untar the LDOPE_irix.tar file as:
>tar -xvf LDOPE_irix.tar

This should show the following files:

```
README_Irix_install.pdf (this file in pdf )
README_Irix_install.txt (this file in text)
HDF4.1r1.tar.gz          (HDF library install)
```

MODAT.tar

(LDOPE tools install)

2. Untar the MODAT.tar files as:

```
>tar -xvf MODAT.tar
```

The MODAT directory should contain the following files and directories:

- README
- MODAT-install.sh
- bin (directory containing executables)
- obj (directory containing object files)
- src (directory containing source code)

3. To compile the source code, the HDF libraries must be installed first. If you already have HDF libraries installed on your machine please go to Step 6.

Gunzip and untar the HDF4.1r1.tar.gz file as:

```
>gunzip HDF4.1r1.tar.gz  
>tar -xvf HDF4.1r1.tar
```

The directory HDF4.1r1 will contain the following files and directories:

- README
- INSTALL
- COPYING (copyrights)
- config.guess
- config.sub
- configure
- configure.in
- install-sh
- Makefile.in
- mkinstalldirs
- move-if-change
- win32mak.zip.uu
- config (directory)
- hdf (directory)
- man (directory)
- mfhdf (directory)
- release_notes (directory)

4. Read the README file for the HDF directory explanations and instructions. Read the INSTALL file for specific installation requirements and supported operating systems.
5. The basic INSTALL functions will be 'configure' and 'make', taking into account any caveats from Step 3.

6. Ensure that the file privilege of the shell file MODAT-install.sh is set to executable as:

```
>chmod +x MODAT-install.sh
```

Invoke the installation shell script as:

```
> ./MODAT-install.sh
```

This script will prompt you to provide the correct HDF library paths in your system.

Compiled executables will be written to the MODAT/bin directory. For convenience you may want to add this directory path to \$PATH environment variable.

7. You may wish to test the correct functioning of the installed tools using the test data sets described in Appendix G.

Contact

LP DAAC Customer Support Center:

http://edcdaac2.usgs.gov/cleopatra/user/help_home.asp

LP DAAC Home Page:

<http://edcdaac.usgs.gov>

Appendix B: Linux Installation

Requirements

These tools work on Linux (Redhat 7.3) Operating Systems.

These tools are available as source code that will need to be compiled or as ready-to-run (run-time) binary executables.

If you wish to compile the source code, you will need the HDF4.1r1 library included with this delivery and a 64-bit C compiler.

If you already have HDF4.1r1 installed on your machine you may not need to install it again, otherwise please follow the instructions for HDF installation provided below. For additional information on the HDF library refer to Appendix E.

It is recommended that a 64-bit C compiler is used. A 32-bit compiler will work but it may generate warning messages during the LDOPE tool installation (e.g., >read_l2g_comp.c warning: decimal constant is so large that it is unsigned).

Instructions for Run-time

1. Save the LDOPE_Linux_bin.tar file to a directory where you want to install the software. Untar the LDOPE_Linux_bin.tar file.
>tar -xvf LDOPE_Linux_bin.tar
There will be one file for each executable, and these run as stand-alone commands.

For convenience you may want to add this binary directory path to the \$PATH environment variable.

2. You may wish to test the correct functioning of the tools using the test data sets described in Appendix G.

Instructions for Source Code

1. Save the LDOPE_Linux.tar file to a directory where you want to install the software. Untar the LDOPE_Linux.tar file as:
>tar -xvf LDOPE_Linux.tar

This should show the following files:

README_linux_install.pdf	(this file in pdf)
README_linux_install.txt	(this file in text)
HDF4.1r1.tar.gz	(HDF library install)
MODAT.tar	(LDOPE tools install)

2. Untar the MODAT.tar files as:

```
>tar -xvf MODAT.tar
```

The MODAT directory should contain the following files and directories:

- README
- MODAT-install.sh
- bin (directory containing executables)
- obj (directory containing object files)
- src (directory containing source code)

3. To compile the source code, the HDF libraries must be installed first. If you already have HDF libraries installed on your machine please go to Step 6.

Gunzip and untar the HDF4.1r1.tar.gz file as:

```
>gunzip HDF4.1r1.tar.gz  
>tar -xvf HDF4.1r1.tar
```

The directory HDF4.1r1 will contain the following files and directories:

- README
- INSTALL
- COPYING (copyrights)
- config.guess
- config.sub
- configure
- configure.in
- install-sh
- Makefile.in
- mkinstalldirs
- move-if-change
- win32mak.zip.uu
- config (directory)
- hdf (directory)
- man (directory)
- mf hdf (directory)
- release_notes (directory)

4. Read the README file for the HDF directory explanations and instructions. Read the INSTALL file for specific installation requirements and supported operating systems.
5. The basic INSTALL functions will be 'configure' and 'make', taking into account any caveats from Step 3.
6. Ensure that the file privilege of the shell file MODAT-install.sh is set to executable as:

```
>chmod +x MODAT-install.sh
```

Invoke the installation shell script as:

```
> ./MODAT-install.sh
```

This script will prompt you to provide the correct HDF library paths in your system.

The compiled executables will be written to the MODAT/bin directory. For convenience you may want to add this directory path to \$PATH environment variable.

7. You may wish to test the correct functioning of the installed tools using the test data sets described in Appendix G.

Contact

LP DAAC Customer Support Center:

http://edcdaac2.usgs.gov/cleopatra/user/help_home.asp

LP DAAC Home Page:

<http://edcdaac.usgs.gov>

Appendix C: Solaris Installation

Requirements

These tools work on the Solaris 2.8 Operating System.

These tools are available as source code that will need to be compiled or as ready-to-run (run-time) binary executables.

If you wish to compile the source code, you will need the HDF4.1r1 library included with this delivery and a 64-bit C compiler.

The HDF4.1r1 library is included in this delivery and hence installation of the HDF library is not required. Please note that installation of the HDF4.1r1 library will not modify/delete any HDF library that you may have already installed on your machine.

Instructions for Run-time

1. Save the LDOPE_Solaris_bin.tar file to a directory where you want to install the software. Untar the LDOPE_Solaris_bin.tar file.
>tar -xvf LDOPE_Solaris_bin.tar
There will be one file for each executable, and these run as stand-alone commands.

For convenience you may want to add this binary directory path to the \$PATH environment variable.

2. You may wish to test the correct functioning of the tools using the test data sets described in Appendix G.

Instructions for Source Code

1. Save the LDOPE_Solaris.tar file to a directory where you want to install the software.
2. Untar the LDOPE_Solaris.tar file as:
>tar -xvf LDOPE_Solaris.tar

The LDOPE_Solaris directory should contain the following files and directories:

- README_Solaris
- LDOPE_Solaris_install.sh
- bin (directory containing executables)
- include (directory containing HDF includes)
- lib (directory containing HDF library)
- obj (directory containing object files)
- src (directory containing source code)

3. -To compile the source code :

- Ensure that the file privilege of the shell file LDOPE_Solaris_install.sh is set to executable as:

```
>chmod +x LDOPE_Solaris_install.sh
```

- Invoke the installation shell script as:

```
> ./LDOPE_Solaris_install.sh
```

This script will prompt you to provide the command of the 64- bit C compiler on your system (e.g., gcc -m64).

The compiled executables will be written to the LDOPE_Solaris/bin directory. For convenience you may want to add this directory path to \$PATH environment variable.

4. You may wish to test the correct functioning of the installed tools using the test data sets described in Appendix G.

Contact

LP DAAC Customer Support Center:

http://edcdaac2.usgs.gov/cleopatra/user/help_home.asp

LP DAAC Home Page:

<http://edcdaac.usgs.gov>

Appendix D: Windows Installation

Requirements

These tools work on the Windows Operating System (Windows 2000/XP).

These tools are available as source code that will need to be compiled or as ready-to-run (run-time) binary executables. The Cygwin1.dll dynamic link library is included in this software and is required to support the ready-to-run version executables.

If you wish to compile the source code, you will need The HDF4.1r1 library (included with this delivery), Red Hat Cygwin (not included with this delivery), and a 32-bit or 64-bit C compiler.

The HDF4.1r1 library is included in this software and hence installation of the HDF library is not required. Please note that installation of the HDF4.1r1 library will not modify/delete any HDF library that you may have already installed on your machine.

If you wish to compile the source code you will need to install Red Hat Cygwin. If you already have Cygwin installed on your machine you do not need to reinstall it. You may download Red Hat Cygwin from the same webpage you downloaded this software and follow the instruction for Cygwin installation provided below. You may also install the Cygwin software directly (from <http://sources.redhat.com/cygwin/>).

It is recommended that a 64-bit C compiler is used. A 32-bit compiler will work but it may generate warning messages during software compilation (e.g., >read_l2g_comp.c warning: decimal constant is so large that it is unsigned).

Instructions for Run-time

1. Save the LDOPE_Win_bin.zip file to a directory where you want to install the software. Unzip the LDOPE_Win_bin.zip file.
>unzip LDOPE_Win_bin.zip
or use a Windows compression utility like Winzip to unzip the LDOPE_Win_bin.zip file.
There will be one file for each executable, and these run as stand-alone commands. They were compiled using a 64-bit C compiler and HDF4.1r1 library under the Windows XP Operating System.

For convenience you may want to add this binary directory path to the \$path environment variable.

2. You may wish to test the correct functioning of the tools using the test data sets described in Appendix G.

Instructions for Source Code

1. Save the LDOPE_Win.zip file to a directory where you want to install the software. Unzip the LDOPE_Win.zip file under Cygwin as:
>unzip LDOPE_Win.zip

or use a Windows compression utility like Winzip to unzip the LDOPE_Win.zip file.

The LDOPE_Win directory should contain the following files and directories:

- README_Win
- LDOPE_Win_install.sh
- bin (directory containing executables & Cygwin1.dll)
- include (directory containing HDF includes)
- lib (directory containing HDF library)
- obj (directory containing object files)
- src (directory containing source code)
- Cygwin (directory for Cygwin licensing doc)

2. To compile the source code, follow Step 3 (only if you do not have Red Hat Cygwin installed) and then Step 4.

3. If Red Hat Cygwin is not installed:

- download the Cygwin_src.zip from the LDOPE Tools download website.
- Create a directory called Cygwin under your C drive.
- Use a Windows compression utility like Winzip to unzip the cygwin_src.zip under the C:\Cygwin directory. Now the C:\Cygwin directory should contain the following files and directories:

- cygwin.bat (cygwin startup script)
- cygwin.ico (cygwin icon)
- bin (directory)
- etc (directory)
- home (directory)
- lib (directory)
- sbin (directory)
- tmp (directory)
- usr (directory)
- var (directory)

- Note, alternatively, you may install Red Hat Cygwin directly from <http://sources.redhat.com/cygwin/>

- Now follow step 4 to install the tool software.

4. Ensure that the file privilege of the shell file LDOPE_Win_install.sh is set to executable as:

```
>chmod +x LDOPE_Win_install.sh
```

Invoke the installation shell script as:

```
> ./LDOPE_Win_install.sh
```

This script will prompt you to provide the command of the C compiler under your system (e.g., gcc).

The compiled executables will be written to the LDOPE_Win/bin directory. For convenience you may want to add this directory path to \$path environment variable.

5. You may wish to test the correct functioning of the installed tools using the test data sets described in Appendix G.

Contact

LP DAAC Customer Support Center:

http://edcdaac2.usgs.gov/cleopatra/user/help_home.asp

LP DAAC Home Page:

<http://edcdaac.usgs.gov>

Appendix E: README for HDF/netCDF 4.1 Distribution

Obtaining the latest version

The most recent version of the distribution can be obtained from the NCSA ftp archive site at:

`ftp://ftp.ncsa.uiuc.edu/HDF/HDF_Current`

NOTE: The MODIS LDOPE Tools require the use of version HDF4.1r1 of the HDF libraries. More current versions of the HDF libraries are not compatible with the LDOPE software.

Distribution Layout

There are five subdirectories in this directory:

`config` -- contains machine dependent makefile fragments(mh-<os>).

`hdf` -- contains the source code for the HDF 'base library', the multi_file annotation interface, the multi_file raster image interface, HDF command line utilities (hdp, the hdf dumper is in mfhdf/), Pablo instrumentation support, and a test suite. It also contains the software distributions for IJPEGE(hdf/jpeg) and ZLIB(hdf/zlib) which are required by the HDF library.
Please see the README in each directory for further info on each package.

`mfhdf` -- contains the netCDF(mfhdf) part of the HDF/netCDF distribution and HDF dumper utility(hdp).

`man` -- incomplete set of man page(s) for HDF.

`release_notes` -- descriptions on new features and bug fixes in this release. Files in this sub-directory can be used as supplemental documentation for HDF4.1. These files are also available on the NCSA ftp server, in /HDF/HDF_Current/release_notes.

Third Party Software Requirements:

1. IJPEGE distribution release 6b(libjpeg.a). The "official" site for this is `ftp://ftp.uu.net/graphics/jpeg/jpegsrc.v6b.tar.gz`
2. ZLIB 1.0.4(libz.a) distribution.

Both of these distributions are included with this distribution in 'hdf/jpeg' and 'hdf/zlib'. The HDF/netCDF base distribution is known to work with these versions only.

System Requirements

To build both HDF and netCDF library from source, you need:

- an ANSI C compiler. The native ANSI compilers on the above platforms are supported. On platforms where no ANSI compiler was available the free GNU ANSI compiler GCC was used.
- a Fortran 77 compiler if you want Fortran support. See above table for platforms where Fortran is supported. You can compile both libraries without Fortran support by setting the Fortran compiler variable 'FC = NONE' in the respective makefile fragment(mh-<os>) found in the top-level 'config' directory. See the INSTALL file for further details on configuration and installation.

NOTE: Since the MODIS LDOPE Tools are written in C, they will not be compatible with the FORTRAN version of the HDF libraries.

Configuring/Testing/Installing

See the INSTALL file for instructions on configuring, testing and installing for Unix and non-UNIX systems.

DOCUMENTATION/FAQ/HELP

The HDF 4.1r1 documentation can be found on the NCSA ftp server in the directory /HDF/Documentation/HDF4.1r1. The HDF home page is at:

<http://hdf.ncsa.uiuc.edu/>

An FAQ is available on our ftp server, as well as under "Information about HDF" in the home page.

If you have any questions or comments, or would like to be added to or removed from our hdfnews email list, contact us at: hdfhelp@ncsa.uiuc.edu

Appendix F: LDOPE Tools Command-line Syntax

A LDOPE tool command consists of a command name followed by one or more arguments. There are two types of arguments: arguments indicating certain processing parameters and arguments that are input filenames.

command_name -argument_name=argument_value filename(s)

Arguments that indicate processing options or parameters start with a – sign. Such arguments have argument name and one or more values separated by comma with no space. Argument values may not be allowed if they are implied by the argument name. In cases where argument value is required but is not input, default value is used. Arguments can be input in any order following the command name.

- ***Use of various brackets in the command syntax***
 - <argx or xval> argument ‘argx’ or argument value ‘xval’ is required.
 - [argy or yval] argument ‘argy’ or argument value ‘yval’ is optional.
 - {argz or zval} argument ‘argz’ or argument value ‘zval’ is repeatable.
- ***Command line arguments and values***
 - argx argument ‘argx’ is used without any value.
 - argy=<yval> argument ‘argy’ is used with a value ‘yval’. Argument value is required. ‘yval’ can be string or numeric.
- ***Common arguments and meaning***
 - help Print help message for the command.
 - help filename Print valid values for the various command line arguments of this command.
 - sds Input SDS names.
 - of Output filename.
 - meta Copy metadata from the input file to the output file.
 - bit Bit numbers.
 - xy Pixel location in sample and line number.
 - bn band numbers.
- **MODISLand data product file specification**

Specification for MODISLand data product is available on the web: ftp://mo1.nascom.nasa.gov:9000/pub/stig_temp/mlinda/www/LatestFilespecs/

Appendix G: QA Tool testing

This document serves as a guide to verification testing of the MODIS LDOPE Tools, i.e. to verify that the software has been installed properly and that it executes correctly. The scenarios included in this document will also familiarize the user with various MODIS product characteristics and data structures. The following scenarios will test how the tools work on different Science Data Sets using different combinations of command options.

There are two files of input data that are made available for testing (Testing_Input1.tar.gz, Testing_Input2.tar.gz), the results from which can be compared to known results that are provided in four files of output data (Testing_Output1.tar.gz, Testing_Output2.tar.gz, Testing_Output3.tar.gz, Testing_Output4.tar.gz). All input and output files are in HDF-EOS format.

Testing_Input1.tar.gz

MOD09.A2001201.1335.003.2001318080318.hdf
MOD09A1.A2002017.h09v05.004.2002208084151.hdf
MODAGAGG.A2001193.h26v04.003.2001308172749.hdf
MODPTHKM.A2001193.h26v04.004.2002198054041.hdf
MYD021KM.A2002189.0350.003.2002191000652.hdf
MYD021KM.A2002208.1925.003.2002209191726.hdf
MYD14GD.A2002225.h21v08.003.2002227234523.hdf
MYD35_L2.A2002189.2040.003.2002191125354.hdf
MYD35_L2.A2002208.1925.003.2002209192643.hdf
MYD35_L2.A2002208.2110.003.2002209195539.hdf
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf

Testing_Input2.tar.gz

MOD09GST.A2001208.h10v11.004.2002276233729.hdf
MOD10L2G.A2001208.h10v11.004.2002276233845.hdf
MOD29PGD.A2001208.h10v11.003.2002276065837.hdf
MODMGGAN.A2001208.h10v11.004.2002276233721.hdf
MODPT1KN.A2001208.h10v11.004.2002276233717.hdf
MODPTHKM.A2001208.h10v11.004.2002276233708.hdf
MODPTPGD.A2001208.h10v11.003.2002276065455.hdf
MODPTPGN.A2001208.h10v11.003.2002276064938.hdf
MYD021KM.A2002208.1930.003.2002209191241.hdf
MYD021KM.A2002208.2105.003.2002209195055.hdf
MYD021KM.A2002208.2110.003.2002209194936.hdf
MYD09GHK.A2002225.h19v10.003.2002228000126.hdf
MYD09GHK.A2002225.h19v11.003.2002228000539.hdf
MYD09GHK.A2002225.h19v12.003.2002227235146.hdf
MYD14GD.A2002225.h21v05.003.2002228002827.hdf
MYD14GD.A2002225.h21v06.003.2002228002759.hdf
MYD14GD.A2002225.h21v07.003.2002227234318.hdf
MYD43B1.A2002177.h03v08.003.2002210144505.hdf
MYD43B1.A2002177.h11v11.003.2002210233848.hdf

Testing Input3.tar.gz

MOD09A1.A2001201.h20v05.003.2002281080105.hdf
MOD09A1.A2001201.h20v06.003.2002281080112.hdf
MOD09A1.A2001201.h21v05.003.2002281080255.hdf
MOD09A1.A2001201.h21v06.003.2002281080110.hdf
MOD09GHK.A2001208.h10v11.004.2002276233751.hdf
MOD12Q1.A2000289.h21v10.003.2002170195353.hdf
MOD14A1.A2002225.h24v04.003.2002245105445.hdf
MOD15A1.A2001193.h09v05.004.2002198025239.hdf
MYD35_L2.A2002208.1930.003.2002209192055.hdf
MYDAGAGG.A2002225.h20v04.003.2002227203243.hdf
MYDAGAGG.A2002225.h20v05.003.2002227202827.hdf
MYDAGAGG.A2002225.h20v06.003.2002227202457.hdf
MYDAGAGG.A2002225.h21v05.003.2002227203558.hdf
MYDAGAGG.A2002225.h21v06.003.2002227203447.hdf
MYDAGAGG.A2002225.h21v07.003.2002227194908.hdf

Testing Output1.tar.gz

tst_1_enlarge_sds_MOD09.A2001201.1335.003.2001318080318.hdf
tst_2_enlarge_sds_MYD35_L2.A2002189.2040.003.2002191125354.hdf
tst_4_enlarge_sds_MYD43B1.A2002177.h11v11.003.2002210233848.hdf
tst_5_enlarge_sds_MODAGAGG.A2001193.h26v04.003.2001308172749.hdf

Testing Output2.tar.gz

tst_1_sds2bin_MYDAGAGG.A2002225.h21v08.003.2002227194922.img
tst_2_sds2bin_MYD35_L2.A2002208.2110.003.2002209195539.img
tst_3_enlarge_sds_MYD021KM.A2002189.0350.003.2002191000652.hdf
tst_3_sds2bin_MYD021KM.A2002208.1925.003.2002209191726.img
tst_4_sds2bin_MYD021KM.A2002208.1925.003.2002209191726.img
tst_5_sds2bin_MYD43B1.A2002177.h03v08.003.2002210144505.img

Testing Output3.tar.gz

tst_6_enlarge_sds_MODAGAGG.A2001193.h26v04.003.2001308172749.hdf

Testing Output4.tar.gz

tst10_mosaic_MYDAGAGG.A2002225.h20-21v4-8.hdf
tst12_mosaic_MOD09A1.A2001201.h20-21.v05-06.hdf
tst1_mosaic_MYD14GD.A2002225.h21v05-v08.hdf
tst3_mosaic_MYD09GHK.A2002225.h19v10-v12.hdf
tst6_mosaic_MYD021KM.A2002208.1925-2110.hdf
tst_1_L2G_MOD09GST.A2001208.h10v11.004.2002276233729.hdf
tst_1_read_meta_MYD021KM.A2002208.1925.003.2002209191726.txt
tst_1_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.txt
tst_1_reduce_sds_MOD15A1.A2001193.h09v05.004.2002198025239.hdf
tst_1_unpack_MOD09A1.A2002017.h09v05.004.2002208084151.hdf
tst_2_L2G_MOD09GHK.A2001208.h10v11.004.2002276233751.hdf

tst_2_read_meta_MYD35_L2.A2002208.2110.003.2002209195539.txt
 tst_2_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
 tst_2_reduce_sds_MOD14A1.A2002225.h24v04.003.2002245105445.hdf
 tst_2_unpack_MOD09A1.A2002017.h09v05.004.2002208084151.hdf
 tst_3_L2G_MOD10L2G.A2001208.h10v11.004.2002276233845.hdf
 tst_3_read_meta_MODPTHKM.A2001193.h26v04.004.2002198054041.txt
 tst_3_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
 tst_3_reduce_sds_MOD12Q1.A2000289.h21v10.003.2002170195353.hdf
 tst_3_unpack_MYD35_L2.A2002208.1925.003.2002209192643.hdf
 tst_4_L2G_MOD29PGD.A2001208.h10v11.003.2002276065837.hdf
 tst_4_read_meta_MYDAGAGG.A2002225.h21v08.003.2002227194922.txt
 tst_4_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
 tst_4_reduce_sds_MYD35_L2.A2002208.1930.003.2002209192055.hdf
 tst_4_unpack_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
 tst_5_L2G_MODMGGAN.A2001208.h10v11.004.2002276233721.hdf
 tst_5_read_meta_MYD43B1.A2002177.h11v11.003.2002210233848.txt
 tst_5_reduce_rank_MYD021KM.A2002208.1925.003.2002209191726.hdf
 tst_6_L2G_MODPTPGN.A2001208.h10v11.003.2002276064938.hdf
 tst_6_read_meta_MYD14GD.A2002225.h21v08.003.2002227234523.txt
 tst_6_reduce_rank_MYD35_L2.A2002208.1930.003.2002209192055.hdf

Enlarge sds

Case 1: enlarge a 2D SDS.

```
enlarge_sds -sds="500m Surface Reflectance Band 1" -sf=4 -
tst_1_enlarge_sds_MOD09.A2001201.1335.003.2001318080318.hdf -meta
MOD09.A2001201.1335.003.2001318080318.hdf
```

Case 2: enlarge all layers in 3D SDSs.

```
enlarge_sds -sf=3
-of=tst_2_enlarge_sds_MYD35_L2.A2002189.2040.003.2002191125354.hdf
-meta -sds="Cloud_Mask.*,Quality_Assurance.*"
MYD35_L2.A2002189.2040.003.2002191125354.hdf
```

Case 3: enlarge a subset of layers in a 3D SDS.

```
enlarge_sds -sf=10
-of=tst_3_enlarge_sds_MYD021KM.A2002189.0350.003.2002191000652.hdf
-sds="EV_1KM_RefSB.4-6" MYD021KM.A2002189.0350.003.2002191000652.hdf
```

Case 4: enlarge all 3rd dimension layers of a specified 4th dimension of a 4D SDS.

```
enlarge_sds -sds="BRDF_Albedo_Parameters.*.2" -sf=2
-of=tst_4_enlarge_sds_MYD43B1.A2002177.h11v11.hdf
MYD43B1.A2002177.h11v11.003.2002210233848.hdf
```

Case 5: enlarge all 3rd dimension layers of specified or all 4th dimension in 4D SDSs.

```
enlarge_sds -sf=2
```

```
-of=tst_5_enlarge_sds_MODAGAGG.A2001193.h26v04.003.2001308172749.hdf
-meta -sds="Angles.*.1, Surface_Refl.*.*"
MODAGAGG.A2001193.h26v04.003.2001308172749.hdf
```

Case 6: Test default option of enlarge_sds. It will enlarge all SDS, all layers, and retain original interleaving.

```
enlarge_sds -sf=3 -meta -
of=tst_6_enlarge_sds_MODAGAGG.A2001193.h26v04.003.2001308172749.hdf
MODAGAGG.A2001193.h26v04.003.2001308172749.hdf
```

read_meta:

Case 1: Test read_meta default option

```
read_meta MYD021KM.A2002208.1925.003.2002209191726.hdf
```

Result: Print to screen. Saved as
tst_1_read_meta_MYD021KM.A2002208.1925.003.2002209191726.txt for
comparison purpose.

Case 2: read only Core metadata.

```
read_meta -core MYD35_L2.A2002208.2110.003.2002209195539.hdf
```

Result: Print to screen. Saved as
tst_2_read_meta_MYD35_L2.A2002208.2110.003.2002209195539.txt for
comparison purpose.

Case 3: read only QA metadata.

```
read_meta -qa MODPTHKM.A2001193.h26v04.004.2002198054041.hdf
```

Result: Print to screen. Saved as
tst_3_read_meta_MODPTHKM.A2001193.h26v04.004.2002198054041.txt for
comparison purpose.

Case 4: read only Archive metadata.

```
read_meta -arch MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
```

Result: Print to screen. Saved as
tst_4_read_meta_MYDAGAGG.A2002225.h21v08.003.2002227194922.txt for
comparison purpose.

Case 5: read selected metadata.

```
read_meta -meta=INPUTPOINTER
MYD43B1.A2002177.h11v11.003.2002210233848.hdf
```

Result: Print to screen. Saved as
tst_5_read_meta_MYD43B1.A2002177.h11v11.003.2002210233848.txt for
comparison purpose.

Case 6: read selected metadata, case insensitive.

```
read_meta -meta=DAYNIGHTFLAG,GRINGPOINTLONGITUDE
MYD14GD.A2002225.h21v08.003.2002227234523.hdf
Result: Print to screen. Saved as
tst_6_read_meta_MYD14GD.A2002225.h21v08.003.2002227234523.txt for
comparison purpose.
```

Unpack_sds_bits

Case 1: unpack a single SDS.

```
unpack_sds_bits -sds=sur_refl_qc_500m -bit=10-13
MOD09A1.A2002017.h09v05.004.2002208084151.hdf -of=
tst_1_unpack_MOD09A1.A2002017.h09v05.004.2002208084151.hdf
```

Case 2: unpack bits of different range of a single SDS.

```
unpack_sds_bits -sds=sur_refl_qc_500m -bit=10-13,14-17,18-21
MOD09A1.A2002017.h09v05.004.2002208084151.hdf -of=
tst_2_unpack_MOD09A1.A2002017.h09v05.004.2002208084151.hdf
```

Case 3: unpack bits of a selected 3rd dimension of a 3D SDS.

```
unpack_sds_bits -sds=Cloud_Mask.1 -meta
-of=tst_3_unpack_MYD35_L2.A2002208.1925.003.2002209192643.hdf -bit=1-2
MYD35_L2.A2002208.1925.003.2002209192643.hdf
```

Case 4: unpack bits of different range of a list of SDSs.

```
unpack_sds_bits -sds=Surface_Ref1,Band_QC -bit=1-3,4-6
-of=tst_4_unpack_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
```

read_l2g

Case 1: extracts layers from a L2G file. (for this example, the output contains 4 SDSs).

```
read_l2g -layer=1-2
-of=tst_1_L2G_MOD09GST.A2001208.h10v11.004.2002276233729.hdf
MOD09GST.A2001208.h10v11.004.2002276233729.hdf
```

Case 2: extracts a list of SDSs of specified granule numbers and layers of a L2G file. (for this example, the output contains 9 SDSs).

```
read_l2g -sds=sur_refl_b01,sur_refl_b03,sur_refl_b04 -layer=1-2
-glist=8552,187 -ptr=MODPTHKM.A2001208.h10v11.004.2002276233708.hdf
-of=tst_2_L2G_MOD09GHK.A2001208.h10v11.004.2002276233751.hdf
MOD09GHK.A2001208.h10v11.004.2002276233751.hdf
```

Case 3: extract SDS by input layer number and granule pointer index. (for this example, 2 SDSs are outputted.)

```
read_l2g -sds=Snow_Cover -layer=2 -gpidx=0
-ptr=MODPTHKM.A2001208.h10v11.004.2002276233708.hdf
-of=tst_3_L2G_MOD10L2G.A2001208.h10v11.004.2002276233845.hdf
MOD10L2G.A2001208.h10v11.004.2002276233845.hdf
```

Case 4: extract all SDSs of a list of granule numbers from a L2G file. (for this example, 24 SDSs are outputted.)

```
read_l2g -glist=8548,102,103 -glist=8549,122,123
-ptr=MODPTPGD.A2001208.h10v11.003.2002276065455.hdf
-of=tst_4_L2G_MOD29PGD.A2001208.h10v11.003.2002276065837.hdf
MOD29PGD.A2001208.h10v11.003.2002276065837.hdf
```

Case 5: extract all SDSs of a specified granule id from a L2G file. (for this example, 6 SDSs are outputted.)

```
read_l2g -gid=A2001208.0430
-ptr=MODPT1KN.A2001208.h10v11.004.2002276233717.hdf
-of=tst_5_L2G_MODMGGAN.A2001208.h10v11.004.2002276233721.hdf
MODMGGAN.A2001208.h10v11.004.2002276233721.hdf
```

Case 6: extract all SDSs of a list of layers from a L2G pointer file. (for this example, 36 SDSs are outputted.)

```
read_l2g -layer=1-6
-of=tst_6_L2G_MODPTPGN.A2001208.h10v11.003.2002276064938.hdf
MODPTPGN.A2001208.h10v11.003.2002276064938.hdf
```

sds2bin

Case 1: Convert a 4D SDS to binary format.

```
sds2bin -sds=Surface_Ref1
-of=tst_1_sds2bin_MYDAGAGG.A2002225.h21v08.003.2002227194922.img
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
```

Case 2: Convert a 3D SDS to binary format.

```
sds2bin -sds=Quality_Assurance.*
-of=tst_2_sds2bin_MYD35_L2.A2002208.2110.003.2002209195539.img
MYD35_L2.A2002208.2110.003.2002209195539.hdf
```

Case 3: Convert selected layers from a 3D SDS to binary format.

```
sds2bin -sds=EV_1KM_Emissive.2-3
-of=tst_3_sds2bin_MYD021KM.A2002208.1925.003.2002209191726.img
MYD021KM.A2002208.1925.003.2002209191726.hdf
```

Case 4: Convert a 2D SDS to binary format.

```
sds2bin -sds=EV_Band26
-of=tst_4_sds2bin_MYD021KM.A2002208.1925.003.2002209191726.img
MYD021KM.A2002208.1925.003.2002209191726.hdf
```

Case 5: Convert selected layers from a 4D SDS to binary format.

```
sds2bin -sds=BRDF_Albedo_Parameters.1-2.2-3
-of=tst_5_sds2bin_MYD43B1.A2002177.h03v08.003.2002210144505.img
MYD43B1.A2002177.h03v08.003.2002210144505.hdf
```

reduce_sds_rank

Case 1: Show how to use the help to get SDS dimension information(name, size) which is useful for processing the data.

```
reduce_sds_rank -help MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
```

The output is saved as :

```
tst_1_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.txt
```

Case 2: Reduce the rank of 4D SDSs.

```
reduce_sds_rank
-of=tst_2_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf -all
```

Case 3: Reduce selected SDS by specified dimension name and range from a 4D SDS.

```
reduce_sds_rank -sds=Angles -dim=Num_Obs_Max,1,4 -dim=Num_Angles,1-4
-of=tst_3_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf -all
```

Case 4: Similar to case 3, but to demo how to selected more than one SDS.

```
reduce_sds_rank -sds=Surface_Ref1 -dim=Num_Obs_Max,1,2
-dim=Num_Land_Bands,1-7 -sds=Band_QC -dim=Num_Obs_Max,1,4
-dim=Num_Band_QC,1-7
-of=tst_4_reduce_rank_MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
```

Case 5: Reduce a 3D SDS. (band sequential format)

```
reduce_sds_rank -sds=EV_1KM_RefSB -dim=Band_1KM_RefSB,1-15
-of=tst_5_reduce_rank_MYD021KM.A2002208.1925.003.2002209191726.hdf
MYD021KM.A2002208.1925.003.2002209191726.hdf -all
```

Case 6: Reduce a 3D SDS. (Band Interleaved by Pixel format)

```
reduce_sds_rank -sds=Quality_Assurance
-of=tst_8_reduce_rank_MYD35_L2.A2002208.1930.003.2002209192055.hdf
MYD35_L2.A2002208.1930.003.2002209192055.hdf -all
```

mosaic_sds

Case 1: Create Mosaic of a 2D SDS.

```
mosaic_sds -sds=fire_mask_1
-of=tst1_mosaic_MYD14GD.A2002225.h21v05-v08.hdf
MYD14GD.A2002225.h21v05.003.2002228002827.hdf
MYD14GD.A2002225.h21v06.003.2002228002759.hdf
MYD14GD.A2002225.h21v07.003.2002227234318.hdf
MYD14GD.A2002225.h21v08.003.2002227234523.hdf
```

Case 2: Create Mosaic of multiple 2D SDSs.

```
mosaic_sds
-sds=sur_refl_b01_1,sur_refl_b02_1,sur_refl_b03_1,sur_refl_b04_1
-of=tst3_mosaic_MYD09GHK.A2002225.h19v10-v12.hdf
MYD09GHK.A2002225.h19v10.003.2002228000126.hdf
MYD09GHK.A2002225.h19v11.003.2002228000539.hdf
MYD09GHK.A2002225.h19v12.003.2002227235146.hdf
```

Case 3: Create Mosaic of a specified layer from a 3D SDS.

```
mosaic_sds -sds="EV_1KM_Emissive.2"
-of=tst6_mosaic_MYD021KM.A2002208.1925-2110.hdf
MYD021KM.A2002208.1925.003.2002209191726.hdf
MYD021KM.A2002208.1930.003.2002209191241.hdf
MYD021KM.A2002208.2105.003.2002209195055.hdf
MYD021KM.A2002208.2110.003.2002209194936.hdf
```

Case 4: Create Mosaic of a specified layer from a 4D SDS.

```
mosaic_sds -sds="Surface_Ref1.1.2"
-of=tst10_mosaic_MYDAGAGG.A2002225.h20-21v4-8.hdf
MYDAGAGG.A2002225.h20v04.003.2002227203243.hdf
MYDAGAGG.A2002225.h20v05.003.2002227202827.hdf
MYDAGAGG.A2002225.h20v06.003.2002227202457.hdf
MYDAGAGG.A2002225.h21v05.003.2002227203558.hdf
MYDAGAGG.A2002225.h21v06.003.2002227203447.hdf
MYDAGAGG.A2002225.h21v07.003.2002227194908.hdf
MYDAGAGG.A2002225.h21v08.003.2002227194922.hdf
```

Case 5: Create mosaic from selected areas of each tile.

```
mosaic_sds -sds=sur_refl_b01,sur_refl_b02
-of= tst12_mosaic_MOD09A1.A2001201.h20-21.v05-06.hdf
MOD09A1.A2001201.h20v05.003.2002281080105.hdf -row=1500,2399
-col=1000,2399 MOD09A1.A2001201.h20v06.003.2002281080112.hdf
-row=0,1200 -col=1000,2399
MOD09A1.A2001201.h21v05.003.2002281080255.hdf -row=1500,2399
-col=0,1200 MOD09A1.A2001201.h21v06.003.2002281080110.hdf
-row=0,1200 -col=0,1200
```

reduce_sds

Case 1: reduce sds using the -sub option.

```
reduce_sds -sds=Fpar_1km -sub -rf=5 -meta
-of=tst_1_reduce_sds_MOD15A1.A2001193.h09v05.004.2002198025239.hdf
MOD15A1.A2001193.h09v05.004.2002198025239.hdf
```

Case 2: reduce sds using the -cnt and -bit option.

```
reduce_sds -sds="most confident detected fire" -rf=5 -cnt
-bit="0-3<=2,0-3==3,0-3==4,0-3==5,0-3==6,0-3==7" -meta
-of=tst_2_reduce_sds_MOD14A1.A2002225.h24v04.003.2002245105445.hdf
MOD14A1.A2002225.h24v04.003.2002245105445.hdf
```

Case 3: reduce sds using the -cl option

```
reduce_sds -rf=4 -cl -meta
-of= tst_3_reduce_sds_MOD12Q1.A2000289.h21v10.003.2002170195353.hdf
MOD12Q1.A2000289.h21v10.003.2002170195353.hdf -meta
```

Case 4: reduce sds using the -avg and -min, -max, -std, -num option.

```
reduce_sds -sds=Cloud_Mask.1-2 -avg -rf=5 -avg -min -max -std -num -of=
tst_4_reduce_sds_MYD35_L2.A2002208.1930.003.2002209192055.hdf
MYD35_L2.A2002208.1930.003.2002209192055.hdf -meta
```

Appendix H: Understanding unpack_sds_bits

All of the MODIS Land products store quality assessment and other important information at the bit level within certain Science Data Sets (SDS). Most basic computer text books describe how numbers are stored in bytes which are composed of 8, 16, 32 or 64 bits, with each bit storing a binary (0 or 1) value.

The MODIS Land products store quality assessment and other information, such as the land-sea mask, logical criteria used by the algorithm, and cloud state, in an efficient bit encoded manner for each pixel. The `unpack_sds_bits` tool decodes requested bit fields and writes them to an output HDF file containing a new SDS that can be viewed with software supporting the HDF or HDF-EOS data formats.

Prior to unpacking the bits, it is important to consult the product User Guide or File Specification to determine the SDS names and the range and definition of the bits for unpacking. Each product will vary in its SDS names and its bit coding and content. The User Guides and File Specifications are available on the internet and may be updated periodically. Please follow the links at http://landdb1.nascom.nasa.gov/QA_WWW/newPage.cgi to find these information.

Example of unpacking file: MOD13A1.A2001225.h11v05.003.2001342094517.hdf

1. Analyze the NDVI quality for MOD13A1, the 500m 16-day MODIS VI product.
2. Reference the MOD13A1 User Guide (http://tbrs.arizona.edu/projects/modis/UserGuide_doc.htm#QASDS1) or File Specification listing (ftp://mol.gsfc.nasa.gov:9000/pub/stig_temp/mlinda/www/LatestFilespecs/MOD13A1.fs) for SDS names and bit information:
3. To get list of SDS names in the input file use
`unpack_sds_bits -help MOD13A1.A2001225.h11v05.003.2001342094517.hdf`
 - 500m 16 days NDVI (2400 x 2400) INT16
 - 500m 16 days EVI (2400 x 2400) INT16
 - 500m 16 days NDVI Quality (2400 x 2400) UINT16
 - 500m 16 days EVI Quality (2400 x 2400) UINT16
 - 500m 16 days red reflectance (2400 x 2400) INT16
 - 500m 16 days NIR reflectance (2400 x 2400) INT16
 - 500m 16 days blue reflectance (2400 x 2400) INT16
 - 500m 16 days MIR reflectance (2400 x 2400) INT16
 - 500m 16 days average view zenith angle (2400 x 2400) INT16
 - 500m 16 days average sun zenith angle (2400 x 2400) INT16
 - 500m 16 days average relative azimuth angle (2400 x 2400) INT16

4. Referencing the User Guide

(http://tbrs.arizona.edu/projects/modis/UserGuide_doc.htm#QASDS1)

Get explanation for values of bits 0-1 and 2-5 for the SDS name '500m 16 days NDVI Quality'.

Bit Descriptions:

0-1 NDVI Quality

00 NDVI produced, good quality

01 NDVI produced, but check QA

10 (pixel not produced, due to cloud effects)

11 (pixel not produced due to other reasons than cloud)

Unpacking bits 0-1 would create a SDS band with the values 0, 1, 2, 3

Bit value 00=0, bit value 01=1, bit value 10=2, bit value 11=3. The digital value of 0 indicates good quality.

Note: Binary conversion is read from right to left. If the bit value was 00011001, the decimal value would be 25. In another example related to the 500m Surface Reflectance QC bits, the bit value of 00001111 converts to a decimal value of 15.

2-5 VI Usefulness Index

0000 Perfect quality (equal to VI quality = 00: VI produced with good quality)

0001 High quality

0010 Good quality

0011 Acceptable quality

0100 Fair quality

0101 Intermediate quality

0110 Below intermediate quality

0111 Average quality

1000 Below average quality

1001 Questionable quality

1010 Above marginal quality

1011 Marginal quality

1100 Low quality

1101 No atmospheric correction performed

1110 Quality too low to be useful

1111 Not useful for other reasons

(equal to VI quality = 11: VI not produced due to bad quality)

Four-bit range

0= highest quality

3= acceptable quality

13= no atmospheric correction,

14= quality too low to be useful

15= not useful for any other reason

Unpacking bits 2-5 would create a SDS band with the values 0 to 15. This description already defines the decimal representation and not the binary value.

Note: The User Guide bit descriptions will vary in their definitions and can reflect binary values or decimal values.

5. `unpack_sds_bits -sds='500m 16 days NDVI Quality' -bit=0-1,2-5 -of=unpack_MOD13A1.A2001225.h11v05.003.2001342094517.hdf MOD13A1.A2001225.h11v05.003.2001342094517.hdf`

** Important to use correct SDS name and bit ranges.

6. ‘unpack_MOD13A1.A2001225.h11v05.003.2001342094517.hdf’ is the output HDF file and can be imported into software supporting HDF or HDF-EOS data formats. There will be two separate SDS names:
500m 16 days NDVI Quality_bits_0-1
500m 16 days NDVI Quality_bit_2-5

The SDS bands can be viewed and used for analysis such as computing statistics, masking or overlaying in conjunction with other SDS layers, i.e. the NDVI band.

Example of unpacking file: MOD43B3.A2001225.h11v05.003.2001342111741.hdf (that contains 3-dimensional SDS).

1. Extract the quality bits for the MODIS band 7 of the 1km 16-day Albedo product (MOD43b3).
2. Reference the MOD43B3 User Guide or File Specification listing for SDS names and bit information:
<http://geography.bu.edu/brdf/userguide/albedo.html>
3. Use ‘unpack_sds_bits -help MOD43B3.A2001225.h11v05.003.2001342111741.hdf’ to get exact list of SDS names.

Albedo_Quality (1200 x 1200 x 2) UINT32

** This is the albedo quality information and is an example of a 3-dimensional SDS. The ‘2’ refers to the size of the 3rd dimension

Albedo (1200 x 1200 x 10 x 2) INT16

** This is an example of a 4-dimensional SDS. The ‘10’ refers to the size of the 3rd

dimension and is the number of bands. The '2' refers to the size of the 4th dimension

and is the number of albedos (black-sky albedo and white-sky albedo for each band.

4. Referencing the User Guide, band quality is stored in the 2nd word or element of the 3rd dimension of SDS name = 'Albedo_Quality'. Within the 2nd word bits 24-27 are used for the band 7 quality information.

Bit Description for Word 2:

00-03 Band 1 Quality

- 0 = RMSE good, WoD(ref) good, WoD(WSA) good
- 1 = RMSE good, WoD(ref) good, WoD(WSA) moderate
- 2 = RMSE good, WoD(ref) moderate, WoD(WSA) good
- 3 = RMSE good, WoD(ref) moderate, WoD(WSA) moderate
- 4 = RMSE moderate, WoD(ref) good, WoD(WSA) good
- 5 = RMSE moderate, WoD(ref) good, WoD(WSA) moderate
- 6 = RMSE moderate, WoD(ref) moderate, WoD(WSA) good
- 7 = RMSE moderate, WoD(ref) moderate, WoD(WSA) moderate
- 8 = magnitude inversion (numobs >=7)
- 9 = magnitude inversion (numobs >3 & <=3)
- 11 = Bus-in DB parameters
- 15 = Fill value

24-27 Band 7 Quality (see explanation above)

5. Unpacking bits 24-27 would create a SDS band with digital values of 0-15.

6. `unpack_sds_bits -sds='Albedo_Quality.2' -bit=24-27`
`-of=unpack_MOD43B3.A2001225.h11v05.003.2001342111741.hdf`
`MOD43B3.A2001225.h11v05.003.2001342111741.hdf`

** The '.2' within -sds refers to the 2nd word or element of the 3rd dimension. The new SDS band within the output HDF file will have the digital values of 0-15.